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Erg Chech 002 crystallized at 4566.6 ± 0.6 Ma dated by ^{53}Mn-^{53}Cr chronometry

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The timing and modes of formation of chemically evolved crusts on early solar system bodies are poorly understood. Here, we present high-precision ^{53}Mn-^{53}Cr dating results (half-life of 3.7 million years) and ε^{54}Cr (per ten thousand deviation of the mass-independent ^{54}Cr/^{52}Cr isotope ratio relative to a terrestrial standard) data for the recent andesitic achondrite meteorite find Erg Chech (EC) 002. We employed TIMS (Berlin) and MC-ICP-MS (Bristol) to measure the Cr isotope compositions and ^{55}Mn/^{52}Cr ratios respectively. Our Cr isotope data reproducibility is ~0.04 (2SD) for both ε^{53}Cr and ε^{54}Cr values, tested using 5 Allende aliquots.

Anchored to the angrite d'Orbigny, the slope of the ^{53}Mn-^{53}Cr isochron established from EC 002 mineral fractions corresponds to an absolute age of 4566.5 ± 0.6 Ma (Figure 1), i.e., 0.8 ± 0.6 Ma after Ca-Al-rich inclusions (CAIs). This age represents the earliest recorded evidence for parent body melting and volcanism in the solar system, suggesting that accretion and planetary differentiation occurred within the first few hundred thousand years of solar system history. The ^{53}Mn-^{53}Cr age is ~1.5 Ma older than the ^{26}Al-^{26}Mg age anchored to CAIs, but consistent with the Al-Mg age anchored to the d'Orbigny angrite. This might indicate heterogeneous initial ^{26}Al/^{27}Al distribution in the CAI and EC 002 formation regions.

Bulk EC 002 shows ε^{54}Cr value of -0.35 ± 0.06, suggesting it is derived from the non-carbonaceous meteorite region of the solar system. Combined with mass independent O isotope data, the ε^{54}Cr values suggests EC 002 may represent the crust of the brachinite parent body. The mineral components of EC 002 shows ε^{54}Cr heterogeneity, ranging from -0.06 ± 0.09 to -0.41 ± 0.10. Mineral fractions of EC 002 related to xenocrystic material in the rock have slightly different ε^{54}Cr values from the bulk, which may reflect lower crustal or mantle heterogeneity, or contamination by material accreted late into the surface of the EC 002 parent body.